

Inclusion of Cross Section Data in PDS PPI Node

Topic

Inclusion of cross sections relevant to planetary science in the Planetary Plasma Interactions (PPI) node of the Planetary Data System (PDS), such as absorption cross sections, photoionization cross sections, electron-impact ionization cross sections, and charge exchange cross sections.

Significance

Cross section data is necessary for both planetary data analysis and modeling. Remote observation of planetary atmospheres includes several techniques—such as auroral measurements—which rely on accurate information regarding electron-impact ionization. Information extracted from atmospheric occultations rely on absorption cross sections. Chemical modeling of atmospheres relies on photoionization, electron-impact ionization, and charge exchange cross sections. Ionospheric and magnetospheric modeling also relies on cross section data in order to account to sources and losses of plasma within the systems being considered.

This non-exhaustive, but indicative list of use cases for cross section data within various disciplines of planetary science demonstrates the wide utility of the data in question. It is therefore unfortunate that such data is not transparently accessible at the present time, with required cross sections often stored in little-known archives belonging to other fields or spread across multiple publications. This situation would be improved significantly by opening of the PPI node to the inclusion of cross section data due to the centrality of the PDS in the planetary science community as well as the universal accessibility and assured retention of data stored within the PDS.

Suggested Improvements/Changes

A method and format for submission of cross section data to the PDS. Cross section data in each category (photoionization, electron-impact, etc.) can be stored in simple tables of cross section vs. energy but several pieces of metadata must be included *by the submitter(s)*, such as:

1. Species involved
2. Description of method of generation for cross sections
3. Date of data generation
4. Usage notes (such as if the data is known to be inappropriate for certain applications)

Other metadata may be generated *by the PDS or the community*, such as:

1. If data is known to be flawed either partially or totally (as a totally flawed dataset is unlikely to be accepted into the PDS, this should take the form of a flag that can be set for each cross section)
2. If other datasets contain cross sections for the same species & energy (again, this should be at the individual cross section level, as datasets may not completely overlap)
3. If the data has been superseded by subsequently submitted datasets (this would likely have to be agreed to by the original submitter)

In addition to simply storing submitted datasets, the ability for the PDS to *synthesize* datasets by combining multiple existing datasets would be desirable. A web-interface for this service could be as simple as dropdown menus for species and fields for energy range and (optionally) energy resolution (this would require a) interpolation and b) a warning that said interpolation may result in the loss of fine scale features). The output would be a table in which each cross section is labeled with source, reliability, and if the value is interpolated. An option for what to do in case of overlap/conflict between datasets should also be included (choices would include a) return multiple values in regions of overlap and b) prompt user to indicate preferred dataset).

Impact of Non-Implementation

The main consequences of the suggested actions not being taken by the PDS are continued inefficiency in conduct of research and continued risk of reliance on superseded or flawed data. The lack of a centralized, uniform, and reliable source for cross section data poses an obstacle to the speed with which existing research projects can be conducted and to the ease with which new research efforts can be started. The difficulty with which cross section data can be discovered currently also creates the risk of data being used which are outdated or flawed simply due to ignorance of either the flaws or the existence of more recent work. The lack of a standard location for storing and accessing cross section data therefore allows for flaws to propagate and cause erroneous results.

Impact of Implementation

Implementation of the above suggestions will result in greater ease of performing work for researchers in a variety of planetary subfields that rely on cross section data. Implementation will also reduce the likelihood of errors propagating into new results which rely on cross section data. Finally, if the above suggestions are followed, researchers who generate cross section data will have greater visibility within the broader planetary science field, and will have a better understanding of the state of knowledge within the field (i.e., gaps in cross section data will be more apparent if all such data is centrally located and searchable). This will incentivize and aid in the generation of new and useful datasets.